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On determining the Longitude at Sea from Altitudes of the Moon.

By Lieut. E. D. Ashe, R.N.

"In the August of 1849 I was invalided at Valparaiso, with a fracture of the thigh-bone, and was ordered a passage to England in the Pandora, surveying-vessel. During my leisure, my attention was drawn to the subject of longitudes, by the circumstance of one of the chronometers (which had gone well for four years) changing its rate very considerably without any assignable cause; and knowing what implicit confidence is placed in a good chronometer, I felt that it was to be lamented that there was not some plan less laborious and of easier attainment than the lunar distance for checking chronometers; for, notwithstanding my experience of more than twenty years' sea time, I can only recollect one instance of the chronometers having been checked by the lunar distance, which may be, perhaps, accounted for by the many inconveniences attending the observation, and the large amount of practice necessary to ensure success."

The data for the problem proposed by Lieut. Ashe are, the sidereal time of the observation, the latitude of the place, and the observed altitude of the moon.

Lieut. Ashe first computes the zenith distance of the moon on the supposition that the observer is on the meridian of Greenwich. As the Greenwich sidereal time is known, the arc of the equinoctial between the moon's node and the meridian may be computed from the *Nautical Almanac*, and the angle which the moon's orbit makes with the equinoctial may be assumed to be equal to the moon's greatest declination. Hence the solution of a right-angled triangle will give the arc *on the moon's orbit*, from her node to the meridian, or arc a; the arc on the meridian between the orbit and the equinoctial, or arc b; and the angle included between these arcs, or γ.

Again, if a perpendicular be let fall from the zenith upon the moon's orbit, the angle in this triangle opposite the perpendicular will be γ, and the hypothenuse is the latitude of the place when increased or diminished by arc b; hence the value of the perpendicular arc, d is found, and also the distance of the foot of the perpendicular from the meridian, e: the addition or subtraction of e to a gives the longitude of the foot of the perpendicular, reckoned on the moon's orbit from the node.

Finally, having the values of the perpendicular on the orbit, and of the moon's zenith distance calculated for the meridian of Greenwich, the third side is computed, which, when applied to the last found arc gives the longitude of the moon on her orbit reckoned from the node,* on the hypothesis that the observer is on the meridian of Greenwich at the sidereal time supposed.

Lieut. Ashe then assumes that the change of meridian from

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* This arc might perhaps be computed less indirectly from the right ascension and declination of the moon.

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Greenwich to the place of observation will not alter the relation of these circles to each other, and that the moon will merely occupy another situation in her orbit. As the zenith distance at the place of observation is supposed to be known, there are, in the right-angled triangle requiring solution, the perpendicular on the moon's orbit, and the observed distance of the moon from the zenith; and from these data the longitude of the moon on her orbit, reckoned from the node, is found for the time and meridian of the place. The difference of the two arcs thus found, divided by the moon's motion, will give the difference in longitude between Greenwich and the place of observation.

Lieut. Ashe suggests a second mode of determining the longitude by an altitude of the moon, when compared with an altitude of the sun or a star.

"For the sake of simplicity, take an example with a star.

"Let the altitude of a star near the prime vertical be taken, and compute its hour-angle. As soon after as may be convenient, take the altitude of the moon, and find her hour-angle; the elapsed sidereal time, and run of the ship (if necessary), being applied to the hour-angle of the star, the hour-angles of moon and star are known at the instant of last observation, and consequently the right ascension of the moon is known from the right ascension of the star. A simple proportion will show what is the Greenwich time corresponding to this right ascension of the moon.'

"When the observations are made on the same side of the meridian, an error in latitude, or instrument, or that caused by bad horizon, or refraction, or personal equation, will not materially affect the 'difference' of the hour-angles, since the errors are common to both triangles Z P S and Z P M, and both are augmented or diminished nearly alike; and therefore the 'difference' between erroneous hour-angles will be nearly equal to the difference between correct hour-angles."

Note.—The practical objection to using altitudes of the moon at sea, for getting the longitude, is, that the horizon is seldom so well defined as to allow of great accuracy, and that, unless the moon's orbit makes a considerable angle with the horizon, her motion in her orbit may not be shown satisfactorily by motion in altitude. The lunar distance observation is capable of much greater accuracy; and by using stars on both sides of the moon, a large portion of the necessary errors of observation are diminished: the motion in her orbit is more favourably shown. The calculations are by no means laborious or complicated; but it must be admitted that great nicety is required to make the observations well, and that the instrument must be of the best kind. On land, perhaps, lunar altitudes would be available in lowish latitudes, as the angle is doubled by the mercurial horizon, and the observation is easy and of great exactness. If a seaman wished to use altitudes of the moon as a coarse check on his chronometer, the easiest method would be to calculate the sidereal time, using the moon as a star, upon two approximate suppositions of the longitude. If that were pretty nearly known, a simple interpolation would show the true longitude; *i. e.* that which gives the true sidereal time, supposed to be already ascertained. But we should guess, in the absence of actual trial, that a very bad lunar distance would give more trustworthy results than a very good lunar altitude.—*Editor.*

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